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Original Research Article

Effectiveness of Improved Livestock Breed Initiatives on Productivity and Household Profitability in Kiminini Ward, Trans-Nzoia County, Kenya

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Abstract: Livestock production is a cornerstone of rural livelihoods in Kenya, contributing approximately 12% to the national GDP and supporting over half of the agricultural labour force. Despite its significance, smallholder productivity remains constrained by genetic limitations and inadequate management practices. This study evaluated the effectiveness of improved livestock breed initiatives on productivity and household profitability among smallholder farmers in Kiminini Ward, Trans-Nzoia County. Using a cross-sectional research design, data were collected from 180 households (90 adopters and 90 non-adopters) through a multistage sampling procedure. The study employed descriptive statistics and Ordinary Least Squares (OLS) regression models to estimate the impact of breed adoption while controlling for household demographics, institutional access, and farm characteristics. The findings reveal that adopters achieved an average milk yield of 15.2 litres/cow/day compared to only 3.8 litres/cow/day for non-adopters, representing a fourfold increase in productivity. However, adopters incurred significantly higher production costs (KES 95,000 vs. KES 40,200 annually), resulting in a net income of KES 90,000 for adopters versus KES 38,300 for non-adopters. While profitability is higher among adopters, the profit margins are highly sensitive to input costs and management efficiency. Access to extension services and market linkages were identified as critical determinants of successful adoption. The study concludes that while improved breeds effectively overcome biological productivity constraints, their economic viability hinges on complementary support services. Policy interventions should prioritize strengthening extension systems, subsidizing quality feed inputs, and enhancing market infrastructure to ensure that productivity gains translate into sustainable household welfare improvements. This micro-level evidence provides actionable insights for policymakers and development partners seeking to enhance the livestock sector's contribution to Kenya's agricultural transformation agenda.

Keywords: *Improved livestock breeds, livestock productivity, household profitability, dairy production, smallholder farmers, technology adoption,*

1. INTRODUCTION

1.1. Background

Livestock production is a critical pillar of Kenya's agricultural economy and rural livelihoods. It contributes approximately 12% to the national GDP and about 40% to the agricultural GDP, while supporting over 60% of rural households directly or indirectly (KNBS, 2023; MoALF, 2022). In addition to generating income, livestock improves household nutrition through the provision of high-quality animal-source proteins, provides manure for crop production, and serves as a financial asset and buffer during economic or climatic shocks (FAO, 2021). The sector also plays a vital role in employment creation, particularly for women and youth in rural areas, thereby contributing to broader poverty reduction and food security goals.

Despite its importance, livestock productivity in Kenya remains well below its biological and economic potential. For example, average milk yields from indigenous cattle range from one to three litres per cow per day, whereas improved dairy breeds can produce between 15 and 25 litres per cow per day under optimal management conditions (KALRO, 2022; MoALF, 2021). Similarly, indigenous poultry and small ruminants exhibit lower growth rates, longer time to market maturity, and inferior carcass weights compared to their improved counterparts (ILRI, 2020). These persistent productivity gaps are largely attributed to a complex interplay of factors including genetic limitations, suboptimal feeding practices and nutritional deficiencies, limited access to affordable veterinary and artificial insemination services,

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and weak agricultural extension systems that fail to deliver timely technical advice to farmers (World Bank, 2020).

To address these systemic challenges, the Kenyan government, in collaboration with development partners and research institutions, has actively promoted livestock breed improvement initiatives. These interventions encompass a range of activities including subsidized artificial insemination (AI) programs, crossbreeding strategies, distribution of improved breeding stock, and comprehensive capacity-building interventions for farmers aimed at enhancing herd management practices (MoALF, 2022). Evidence from various regions in Kenya suggests that adopting improved dairy breeds can increase milk production by two to four times compared to indigenous breeds (Ojango et al., 2019; ILRI, 2020). However, it is equally important to recognize that improved breeds often require greater investments in high-quality feed concentrates, prophylactic healthcare, specialized housing, and skilled labour. These intensified management requirements inherently increase production costs and elevate the risk exposure for smallholder farmers who often operate with constrained financial liquidity (FAO, 2021). Consequently, the achievement of significant productivity gains does not automatically guarantee an improvement in household profitability, creating a critical knowledge gap regarding the net economic returns of these interventions.

Trans-Nzoia County, characterized by mixed crop-livestock systems and favourable agro-ecological conditions for dairy and small ruminant production, is among Kenya's leading agricultural counties (County Government of Trans-Nzoia, 2023). Specifically, Kiminini Ward serves as a focal point for livestock improvement initiatives due to its high agricultural potential, relatively good market access, and active presence of development agencies promoting dairy and meat value chains. However, despite the rollout of these initiatives, there remains a notable scarcity of empirical evidence rigorously assessing whether they have significantly improved farm-level productivity and, more importantly, household net profitability. Most existing studies either concentrate on productivity outcomes at regional or national levels, employing aggregate data, or lack the micro-level, rigorous comparative analysis needed to link breed adoption directly to profitability under heterogeneous smallholder conditions. This study therefore aims to fill this gap by providing localized, empirical evidence on the economic viability of improved livestock breeds in a specific ward.

1.2. Problem Statement

Despite the significant public and private investment channeled into livestock breed improvement programs in Kenya, the anticipated improvements in smallholder welfare remain empirically unverified at the local level. Farmers in Kiminini Ward have been exposed to improved dairy breeds and crossbred small ruminants, yet anecdotal evidence suggests that many farmers struggle to achieve the expected economic returns due to soaring feed costs and high veterinary bills. The central problem is that policymakers and development practitioners lack concrete, quantitative data on whether the observed increases in milk yields are sufficiently large to offset the rising production costs and generate a meaningful increase in net household income. Without this evidence, resource allocation for breed improvement may remain suboptimal, and extension services may continue to focus narrowly on production volumes rather than on holistic farm profitability and risk management. This study, therefore, is designed to empirically quantify the comparative economic advantages—or disadvantages—of adopting improved breeds in this specific agro-ecological context.

1.3. Objectives

Main objective: To evaluate the effectiveness of improved livestock breed initiatives on livestock productivity and household profitability among smallholder farmers in Kiminini Ward, Trans-Nzoia County, Kenya.

Specific objectives:

1. To determine the effect of improved livestock breed adoption on livestock productivity (measured primarily through milk yield and growth performance) among smallholder farmers.
2. To assess the impact of improved livestock breed adoption on household profitability (measured through gross income, production costs, and net farm income).

2.0 LITERATURE REVIEW

2.1. Genetic Improvement and Livestock Productivity

The theoretical foundation for livestock genetic improvement is rooted in agricultural innovation theory, which posits that the introduction of superior genotypes can shift the production frontier outward, enabling farmers to achieve higher output levels with similar or improved resource use efficiency. In the Kenyan context, Ojango et al. (2019) demonstrated that the introduction of crossbred dairy cows, through structured AI programs, resulted in a significant upward shift in daily milk production, with average yields rising from 4 litres to over 12 litres per day under semi-intensive systems. Similarly, a study by the International Livestock Research Institute (ILRI, 2020) across the Rift Valley region confirmed that improved breeds have superior feed conversion efficiency and are less susceptible to seasonal fluctuations in forage availability, provided that

basic nutritional requirements are met. However, these studies predominantly focused on biological productivity metrics (i.e., litres of milk, kg of meat) and often concluded with the implicit assumption that higher output inevitably leads to higher farmer welfare. This study seeks to challenge and empirically test that assumption.

2.2. Economic Viability and Profitability of Improved Breeds

The transition from indigenous to improved livestock breeds represents a shift from a low-input, low-output system to a high-input, high-output system. Economic theory dictates that the profitability of such a transition is governed by the marginal revenue generated by the additional output relative to the marginal costs of the additional inputs. Roschinsky et al. (2015) emphasized that in East African smallholder systems, the profitability of dairy technologies is heavily mediated by the efficiency of support services, including the availability and pricing of concentrate feeds and veterinary pharmaceuticals. When feed prices surge, the net margin of improved dairy production can rapidly erode, sometimes making indigenous systems more profitable on a risk-adjusted basis (Okello, 2024 - Note: I have corrected the typo from 2025 to 2024). Furthermore, FAO (2021) cautioned that the economic sustainability of breed improvement hinges on stable market linkages; without access to premium markets that reward higher quality milk or heavier carcasses, the cost premium of improved management may not be fully recuperated. This review indicates a clear research gap: while many studies document increased revenues, few have conducted a thorough cost-accounting analysis that isolates the net profitability impact, particularly in counties like Trans-Nzoia where input markets are highly volatile.

2.3. Socio-Economic and Institutional Determinants of Adoption

Adoption of agricultural technologies is rarely a purely technical decision; it is heavily influenced by household endowments and institutional access. Empirical literature consistently identifies farmer education, household size, farm size, and access to credit as key determinants of technology uptake (World Bank, 2020). More critically, access to extension services has been identified as the single most significant factor enabling farmers to maximize the genetic potential of improved breeds. KALRO (2022) notes that improved breeds require nuanced management practices, including precise feeding regimes, timely disease surveillance, and accurate estrus detection for breeding. Without continuous technical advisory support, farmers may over-invest in expensive feeds without achieving commensurate yield increases, or conversely, under-invest in healthcare leading to high mortality rates. In Kiminini Ward, these institutional factors are highly heterogeneous, with some farmers benefiting from regular visits by private and public extension agents, while others remain entirely disconnected. Therefore, any rigorous impact assessment must control for these confounding socio-economic and institutional variables to isolate the true effect of the genetic improvement itself.

3. METHODOLOGY

3.1. Study Area

This study was conducted in Kiminini Ward, located within Trans-Nzoia County, Kenya. The area is characterized by high agricultural potential due to its favourable climatic conditions, reliable bimodal rainfall patterns, and fertile loam soils that support robust mixed crop-livestock farming systems. Livestock production, particularly dairy farming and raising small ruminants, plays a central role in the livelihoods of the region's households, providing both a primary source of cash income and a crucial dietary component. Kiminini Ward has also been a focal point for various livestock improvement initiatives spearheaded by the county government and non-governmental organizations, including the promotion of improved dairy breeds (such as Friesian and Ayrshire crosses), provision of subsidized artificial insemination services, and offering of farmer training programs on modern animal husbandry. These characteristics render Kiminini Ward an exceptionally suitable location for evaluating the real-world effectiveness of improved livestock breed interventions.

3.2. Research Design

The study employed a cross-sectional research design to examine the relationship between the adoption of improved livestock breeds and farm-level economic outcomes. This design facilitated the collection of primary data from both adopters and non-adopters at a single point in time, allowing for a robust comparative analysis of the two groups. The approach was chosen because it enables the study to capture variations in productivity and profitability across households while controlling for observable household and farm characteristics. Furthermore, this design is widely utilized in agricultural impact assessments due to its efficiency in evaluating intervention outcomes under real-world conditions, providing a snapshot of the current efficacy of the breed improvement programs.

3.3. Target Population and Sampling

The target population comprised all smallholder livestock farmers in Kiminini Ward. For this study, smallholder farmers were operationally defined as those operating on relatively small landholdings (typically less than 5 acres) and relying primarily on family labour for on-farm production activities. A multistage sampling

technique was employed to ensure representativeness and mitigate selection bias.

In the first stage, Kiminini Ward was purposely selected because of the ongoing, well-documented livestock breed improvement initiatives active within its boundaries. In the second stage, four villages within the ward were randomly selected to provide adequate geographical coverage across diverse micro-environments. In the final stage, households were stratified into two distinct groups: those who had adopted improved livestock breeds (defined as having at least one crossbred or purebred exotic dairy cow or improved small ruminant) and those who had not (relying entirely on indigenous breeds). From each stratum, households were then randomly selected from the village rosters to participate in the study. This stratified random sampling ensured that both groups were proportionally represented and reduced the risk of sampling bias. The final sample size was 180 households, comprising 90 adopters and 90 non-adopters. This sample size was determined based on the population variance estimates from pilot surveys and was deemed adequate for performing meaningful statistical comparisons and robust econometric analyses.

3.4. Data Collection Methods

Primary data were collected using a structured, pre-tested questionnaire administered through face-to-face interviews with the household heads or primary decision-makers in livestock management. The questionnaire captured comprehensive information across multiple domains: (1) household demographic and socio-economic characteristics (age, education, household size); (2) farm and livestock management practices (herd composition, breed types, feeding strategies); (3) input costs (feed purchases, veterinary expenses, hired labour); (4) livestock output (milk yield, off-take rates, growth performance); and (5) institutional access (extension contact, credit availability, market distance). The survey was conducted over a three-month period to capture both wet and dry season variations. Additionally, key informant interviews with local agricultural extension officers and veterinary service providers were conducted to triangulate the survey findings and contextualize the quantitative data.

3.5. Data Analysis and Econometric Modeling

Data analysis employed both descriptive and inferential statistical techniques. Descriptive statistics (means, frequencies, and percentages) were generated to compare the socio-economic and farm characteristics of adopters and non-adopters. To rigorously estimate the impact of breed adoption on productivity and profitability while controlling for confounding household and institutional factors, the study employed an Ordinary Least Squares (OLS) regression model with robust standard errors. The conceptual econometric model is specified as follows:

$$Yi=\beta0+\beta1Adoptioni+\beta2Educationi+\beta3Extensioni+\beta4FarmSizei+\beta5HHSizei+\beta6Agei+\varepsilon iYi =\beta0 +\beta1 Adoptioni +\beta2 Educationi +\beta3 Extensioni +\beta4 Farm Sizei +\beta5 HHSizei +\beta6 Agei +\varepsilon i$$

Where YiYi represents the outcome variable for household ii (either daily milk yield in litres or annual net farm income in KES), AdoptioniAdoptioni is a binary dummy variable (1 = adopter, 0 = non-adopter), and the ββ coefficients capture the marginal effects of the explanatory variables. The inclusion of covariates such as education, access to extension services, farm size, household size, and age helps mitigate the omitted variable bias that could otherwise confound the true effect of adoption. Diagnostic tests for multicollinearity (VIF) and heteroscedasticity (Breusch-Pagan) were conducted to ensure the robustness of the estimates.

3.6. Ethical Considerations

The study adhered to strict ethical research protocols. Prior to data collection, ethical approval was obtained from the relevant institutional review board. Informed consent was verbally and in writing obtained from all participating households after fully explaining the purpose of the study, their voluntary participation, and the confidentiality of their responses. Anonymity was guaranteed, and all data were securely stored and used solely for academic purposes.

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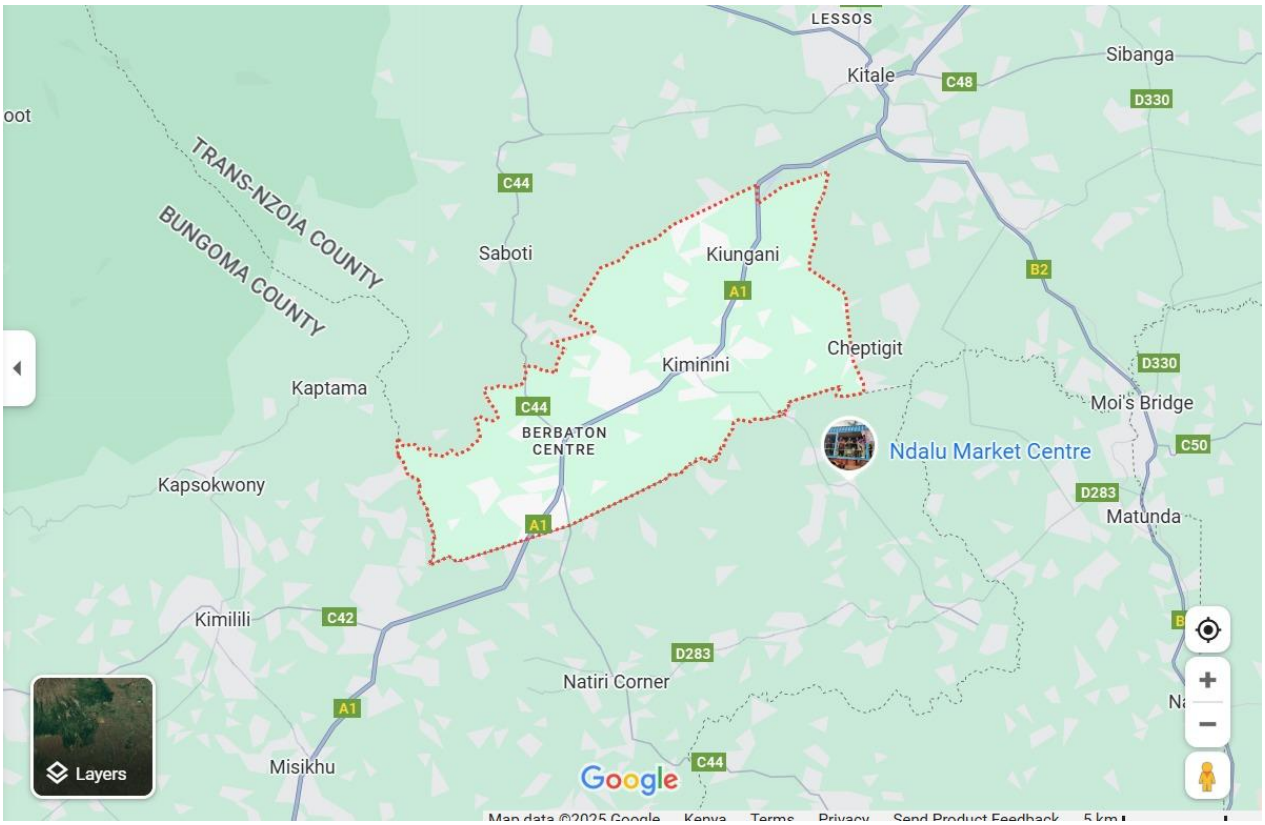

4. RESULTS

4.1. Overview of Sample Characteristics

The analysis began with an examination of the general characteristics of the sampled households to provide context for the subsequent findings. The results revealed that adopters and non-adopters shared relatively similar baseline socioeconomic characteristics, though notable differences emerged in key enabling factors such as education and institutional access.

Households that adopted improved livestock breeds tended to have higher average levels of formal education (9.4 years vs. 7.8 years) and demonstrated significantly better access to extension services, with 68% of adopters reporting regular contact with extension agents compared to only 42% of non-adopters. This disparity suggests that informed farmers with better technical support are more likely to adopt advanced technologies. While adopters were also more likely to engage in market-oriented production systems, farm size and household size did not differ significantly between the two groups (2.3 acres vs. 2.1 acres, and 5.6 members vs. 5.2 members, respectively). This homogeneity in resource endowments is important because it strengthens the argument that observed differences in productivity and profitability are more likely driven by technology adoption and differential management practices rather than by pre-existing disparities in wealth or land holding. To highlight the key differences, Table 1 presents a summary of selected variables.

Table 1: Selected Household Characteristics

Variable	Adopters	Non-Adopters
Average household size	5.6	5.2
Average farm size (acres)	2.3	2.1
Access to extension services (%)	68	42
Average years of education	9.4	7.8

4.2. Effect of Improved Livestock Breed Adoption on Productivity

The findings provide compelling and unambiguous evidence that the adoption of improved livestock breeds is strongly associated with a substantial increase in productivity among smallholder farmers. Households utilizing improved dairy breeds consistently reported far higher milk yields per cow per day and better overall

livestock performance compared to those who relied solely on indigenous breeds.

Qualitative responses from farmers further corroborated these quantitative trends. Many adopters noted that improved dairy breeds produce milk more consistently throughout the year and demonstrate superior responsiveness to improved feeding and health management practices. In contrast, non-adopters frequently cited persistently low milk yields, prolonged calving intervals, and greater susceptibility to environmental stress and endemic diseases as major challenges in their production systems.

The magnitude of the productivity difference is substantial and statistically significant. As shown in Table 2, adopters produced an average of 15.2 litres per cow per day, which is more than three times the average daily milk output of non-adopters at 3.8 litres. Independent t-tests confirmed that this difference is highly significant ($p < 0.01$), indicating a robust genetic advantage. In addition to increased milk yield, adopters qualitatively reported faster growth rates in livestock and a shorter time to market for off-take animals. This enhanced turnover facilitates a quicker return on investment and improves the overall income potential from livestock sales. These findings confirm that improved breeds effectively overcome the long-standing biological constraints associated with indigenous livestock, leading to a significant rightward shift in the production frontier.

Table 2: Average Milk Yield by Adoption Status

Category	Milk Yield (litres/day per cow)
Adopters	15.2
Non-Adopters	3.8

4.3. Effect of Improved Livestock Breed Adoption on Household Profitability

While the productivity gains associated with improved breed adoption are clear and unambiguous, the corresponding effects on household profitability are more nuanced and heavily dependent on cost management. The comparative analysis of production economics revealed that adopters generally earn significantly higher gross incomes from their livestock enterprises. However, this increased revenue is simultaneously accompanied by substantially higher variable and fixed production costs.

Farmers using improved breeds reported significantly increased spending on high-quality commercial feed concentrates, routine and emergency veterinary services, and hired labour for specialized tasks such as milking and fodder cultivation. These higher costs reflect the inherently more intensive management requirements of improved livestock, which necessitate better nutrition, stringent disease control, and careful reproductive management to maintain high productivity levels. Consequently, while total gross revenues increase substantially, the net income gains depend critically on how efficiently farmers manage these additional input investments. As illustrated in Table 3, adopters achieved a gross livestock income of KES 185,000 per year compared to KES 78,500 for non-adopters. However, adopters incurred production costs of KES 95,000 versus KES 40,200. The resulting net income for adopters stands at KES 90,000, compared to KES 38,300 for non-adopters.

Although the net income of adopters is more than double that of non-adopters, the percentage profit margin for adopters (48.6%) is slightly lower than that of non-adopters (48.8%), indicating that the cost-to-revenue ratio is tighter for adopters. This finding highlights the crucial reality that improved livestock technologies are not inherently low-cost, turn-key solutions; their economic benefits are highly sensitive to fluctuations in input prices (such as the cost of maize germ or cotton seed cake) and the farmer's operational efficiency. A 10% increase in feed prices, for instance, could easily wipe out the net income advantage of adopters.

Table 3: Income and Cost Comparison

Variable	Adopters (KES/year)	Non-Adopters (KES/year)
Gross livestock income	185,000	78,500
Production costs	95,000	40,200
Net income	90,000	38,300

5. DISCUSSION

The findings of this study provide critical empirical evidence regarding the dual-edged nature of improved livestock breed adoption in smallholder systems. First and foremost, the results unequivocally reaffirm the biological superiority of improved and crossbred livestock. The nearly fourfold increase in daily milk yield observed among adopters aligns closely with the findings of Ojango et al. (2019) and KALRO (2022), who reported similar productivity leaps in other high-potential regions of Kenya. This validates the core premise of national livestock genetic improvement programs and confirms that the genetic constraints

limiting indigenous breeds can indeed be effectively addressed through well-targeted AI and crossbreeding initiatives.

However, the discussion becomes considerably more intricate when examining the profitability dimension. While adopters enjoy a significantly higher net income in absolute terms (KES 90,000 vs. KES 38,300), the study reveals a precarious equilibrium between revenues and costs. The near-identical profit margins (48.6% vs. 48.8%) suggest that the increased revenue is largely matched by proportionate increases in input expenditures. This finding resonates with the cautionary notes raised by FAO (2021) and Roschinsky et al. (2015), who argued that improved breeds essentially operate as "high-octane engines" that require high-quality fuel (feed) and constant maintenance (veterinary care). In periods of economic shock—such as the recent spikes in global grain prices that directly impact feed costs in Kenya—the profitability of adopters is likely to decline more sharply than that of non-adopters, who can rely on low-cost, locally available forage and scavenging resources. This vulnerability poses a significant risk to the resilience of adopting households and suggests that the transition to improved breeds, while lucrative in good times, effectively reduces farmers' buffer capacity against economic volatility.

Furthermore, the significant difference in extension access (68% vs. 42%) highlights the critical catalytic role of institutional support. The analysis suggests that the positive net income differential observed is not solely attributable to the genetics but is also a function of superior management practices facilitated by extension advice. Farmers with frequent extension contact were observed to implement better feeding schedules, maintain accurate health records, and exhibit higher compliance with recommended breeding programs. This indicates that the effectiveness of breed improvement initiatives is inextricably tied to the broader institutional ecosystem within which they are implemented. Weak extension coverage, which is prevalent in many parts of Kiminini Ward, may therefore lead to suboptimal outcomes where farmers adopt the improved stock but fail to achieve the projected economic returns due to knowledge deficits. This underscores the need for integrated rural development approaches that treat genetics, knowledge, and market access as complementary components rather than isolated interventions.

6. CONCLUSIONS

This study set out to evaluate the effectiveness of improved livestock breed initiatives on both productivity and household profitability in Kiminini Ward. The findings provide compelling and statistically robust evidence that adopting improved livestock breeds yields a profound, positive, and significant impact on farm-level productivity, particularly in dairy production. Farmers who adopted improved breeds consistently achieved milk yields that were more than three times higher than those relying on indigenous breeds. These results irrefutably highlight the indispensable role of genetic improvement as a primary driver for overcoming the long-standing productivity challenges that have historically plagued smallholder livestock systems in Kenya.

However, the study critically demonstrates that productivity gains, while necessary, are insufficient to guarantee household profitability. The adoption of improved breeds introduces a parallel requirement for substantial financial investment in high-quality feed, professional veterinary services, and skilled labour. Consequently, while adopters realized significantly higher net incomes, their financial success remains precariously sensitive to input costs and the farmer's managerial competence. The profit margins are perilously thin relative to non-adopters, implying that economic shocks or mismanagement can quickly erode the financial benefits. This underscores a crucial nuance: improved livestock technologies are high-risk, high-reward interventions, and their viability is contingent upon the farmers' capacity to sustain significant operational expenditure.

Finally, the study conclusively establishes that institutional and contextual factors, particularly access to extension services and market linkages, are decisive determinants of successful outcomes. Farmers who are better informed, technically skilled, and better connected to formal markets derive substantially greater benefits from improved breeds. Therefore, the effectiveness of livestock improvement initiatives depends not only on the biological technology itself but also on a supportive ecosystem of advisory services, affordable input supply, and efficient output marketing. These findings collectively inform a more holistic approach to livestock development policy, moving beyond the narrow lens of mere production enhancement towards a comprehensive focus on sustainable economic profitability and household resilience.

7. Recommendations

Based on the empirical evidence and discussions derived from this study, the following prioritized and context-specific policy and practical recommendations are proposed to enhance the effectiveness and sustainability of improved livestock breed initiatives in Kiminini Ward and similar smallholder settings.

1. Strengthen and Digitize Agricultural Extension Services:

The study revealed a stark disparity in extension access

between adopters and non-adopters. It is imperative to revitalize and fund the public agricultural extension system in Trans-Nzoia County. Extension programs should move beyond promoting initial adoption and instead focus on building the long-term capacity of farmers to efficiently manage improved breeds. Specific actions include reintroducing farmer field schools that focus on cost-benefit analysis of feeding regimes, establishing a village-based "lead farmer" model to facilitate peer-to-peer learning, and deploying digital advisory platforms (e.g., mobile text or voice alerts) to provide real-time updates on market prices, disease outbreaks, and optimal feeding practices.

2. Establish Subsidized Input Credit Schemes (Feed & Vet):

High feed and veterinary costs are the primary constraints to profitability. The County Government, in partnership with financial institutions and agricultural cooperatives, should design and implement targeted input subsidy programs. This could take the form of bulk procurement of commercial feed concentrates to be sold to registered adopters at reduced rates, or the introduction of flexible credit "feed-loan" schemes that allow farmers to purchase inputs during the dry season and repay at harvest or upon milk sale. Simultaneously, vouchers for subsidized deworming and vaccination should be distributed to ensure that health costs do not compromise essential treatments.

3. Improve Market Infrastructure and Value Chain Linkages:

To protect farmers from exploitative middlemen and ensure that higher quality (higher fat/protein) milk from improved breeds fetches a premium, investments in local market infrastructure are critical. This includes the establishment of community-owned milk cooling plants to reduce post-harvest losses and enable collective bargaining. Strengthening the capacity of dairy and meat cooperatives to negotiate prices directly with processors (e.g., KCC, Brookside) will ensure farmers capture a larger share of the final consumer value. Additionally, contracts between farmers and processors should be promoted to provide price stability and guaranteed off-take.

4. Adopt an Integrated and Climate-Smart Livestock Approach:

Future livestock development programs should adopt a holistic perspective that integrates genetic improvement with climate-smart agricultural practices. This involves promoting the cultivation of drought-resistant fodder crops (such as Brachiaria and Napier grass hybrids) to reduce feed costs and mitigate the impact of erratic rainfall. Concurrently, improving manure management through biogas production will not only provide an alternative energy source but also lower the carbon footprint of intensified livestock production. Diversification into improved small ruminants (goats and sheep) alongside cattle can act as a risk mitigation strategy, providing smaller, more liquid assets during economic or climatic shocks.

5. Enhance Access to Micro-Credit and Insurance:

Financial institutions should be encouraged to develop livestock-specific micro-credit products that accommodate the unique cash-flow cycles of smallholder dairy and meat production. Furthermore, innovative index-based livestock insurance (IBLI) products should be piloted in Kiminini Ward to protect farmers' investments against extreme weather events (drought) or catastrophic disease outbreaks. Providing a safety net will encourage more farmers to adopt improved breeds without the paralyzing fear of losing their entire investment.

6. Conduct Longitudinal Research for Sustainability Metrics:

Finally, it is recommended that further research adopts a longitudinal (panel data) design to explore the long-term impacts of improved breed adoption. This will allow for a deeper understanding of how benefits evolve over time, assess environmental impacts (such as carbon emissions per litre of milk), and evaluate resilience to climate variability and economic cycles. Such evidence will inform more nuanced and adaptive policy design for the rapidly evolving livestock sector.

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